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## Reduction in teenage pregnancies – a cross-sectional multinational study

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**Reduction in teenage pregnancies – a cross-sectional multinational study**

Running title: Reduction in teenage pregnancies – a cross-sectional multinational study

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## ABSTRACT

**Objectives:** Compare hormonal contraceptive use, birth and abortion rates among teenagers in the Nordic countries. A secondary aim was to explore plausible explanations for possible differences.

**Design:** Cross-sectional study utilising National registry data concerning abortions and births among all women aged 15-19 years resident in Denmark, Finland, Iceland, Norway and Sweden 1975-2015. Age specific data on prescriptions for hormonal contraceptives for the period 2008-2015 were obtained from national databases in Denmark, Norway, and Sweden.

**Setting:** Denmark, Finland, Iceland, Norway and Sweden.

**Participants:** Women 15-19 years old in all Nordic countries (749 709) and 13-19 years old in Denmark, Norway and Sweden (815 044).

**Results:** Annual birth rates declined in all the Nordic countries with the steepest decline in Norway and Iceland from  $\approx 40$  births/1000 teenagers to 5 and 8, respectively. The annual abortion rates fell from 26 to 11 in Denmark, 21 to 8 in Finland, 17 to 13 in Iceland, 20 to 8 in Norway and from 29 to 14/1000 teenagers in Sweden. The highest user rate of hormonal contraceptive was observed in Denmark (from 51 to 47%) followed by Sweden (from 39 to 42%) and Norway (from 37 to 41%). Combined oral contraceptives were the most commonly used method in all countries. The use of the long-acting reversible contraceptives (LARC), implants and levonorgestrel-releasing intrauterine systems, was increasing, especially in Sweden (5 to 13%) and Norway (1 to 7%). In the subgroup of 18-19 years old teenagers the user rates of hormonal contraceptives went from 63 to 61% in Denmark, 56 to 61% in Norway and 54 to 56% in Sweden.

**Conclusions:** Birth and abortion rates have continuously declined in the Nordic countries among teenagers. There was a high user rate of hormonal contraceptives, with an increase in the use of LARC especially among the oldest teenagers.

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**STRENGTHS AND LIMITATIONS OF THIS STUDY**

- The main strength of this study was the use of national register data, including all adolescents in the Nordic countries.
- In this study data on redeemed prescriptions has been used since it has been shown to be more reliable than self-reported use of contraceptives.
- Non-hormonal contraceptives are not registered in any of the national databases and hence were not included in this study.
- Since personal identification data is not recorded for contraceptive sales in Finland and Iceland, use of hormonal contraceptives were only available from Denmark, Norway and Sweden.

**TRIAL REGISTRATION NUMBER:** Not applicable

**KEY WORDS:** Teenagers; Contraceptive use; Abortion; Births; Hormonal contraception

**ABBREVIATIONS:**

COC –Combined oral contraception, CHC –Combined hormonal contraception, POP Progestogen only pill, LARC –Long-acting Reversible Contraception, LNG-IUS –Levonorgestrel-releasing intrauterine system

## 73 INTRODUCTION

74 Teenage pregnancy is regarded as a challenge both to society and the teenager.[1]  
75 Adolescent pregnancy and motherhood is associated with low socioeconomic status,  
76 early school leaving, and poor health of the mother during and after pregnancy.[2-6].  
77 Also the child of a teenage mother is at risk both during the perinatal period and in the  
78 long-term.[2] Socioeconomic deprivation is considered to be both an effect of and a risk  
79 factor for teenage births. Hence ill-health and low socioeconomic status are often  
80 disseminated across generations.[6 7] Not only teenage motherhood, but also teenage  
81 abortions are considered an important issue, since they increase the risk of subsequent  
82 abortion as well as the risk of additional teenage births.[8-10]

83 In the United States and Europe the rates of teenage pregnancies are declining [11], but  
84 there is a large variation both between the United States and Europe, and within the  
85 European continent.[12] The outcome of pregnancies differs greatly, where in some  
86 regions most of the teenage pregnancies end with an induced abortion, while in others a  
87 pregnancy is usually continued to term. Although the United States has witnessed a  
88 steadily declining teenage pregnancy rate (57/1000 in 2011), it is still comparable to the  
89 highest rates seen in the east-European countries. For example, an incidence of 60/1000  
90 of adolescent pregnancy has recently been reported from Romania and Bulgaria.[12] In  
91 Northern Europe pregnancy rates vary between high levels of pregnancies and births in  
92 England and Wales (47/1000 in 2011) and much lower overall pregnancy rates in the  
93 Nordic countries.[12]

94 The declining rate of teenage pregnancy in the Nordic countries has been documented in  
95 several studies.[13-15] It has been suggested that an increasing availability of  
96 contraceptives is one of the reasons for the decline. Patterns of contraceptive use among  
97 teenagers have been described in individual Nordic countries [14 16 17] and as part of  
98 European surveys. [18 19] However, recent and comprehensive studies, including data  
99 on both pregnancies and contraceptive use among all Nordic teenagers, are lacking.

100 The aim of this study was to compare hormonal contraceptive use, birth and abortion  
101 rates among teenagers in the Nordic countries. A secondary aim was to explore  
102 plausible explanations for possible differences.

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**MATERIAL AND METHODS**

National data on abortion and birth rates among teenagers were compiled from the five Nordic countries Denmark, Finland, Iceland, Norway and Sweden from 1975 to 2015.

Data regarding the use of hormonal contraceptives for the period 2008-2015 were only available from Denmark, Norway and, Sweden as personal identification data is not recorded for contraceptive sales in Finland and Iceland.

Information on birth and abortion rates were collected from the National Health Registries[20] and the Tigrab Database[21] in Denmark, The National Institute for Health and Welfare in Finland [22], the Directorate of Health in Iceland,[23] the Norwegian Institute of Public Health[24] and the National Board of Health and Welfare in Sweden.[25] Birth and abortion rates were expressed as the number of births or abortions/1000 women and year in a certain age group according to international practice. When displaying the overall teenage birth and abortion rates, all births or abortions during one year among women  $\leq 19$  years of age were included. Even though there is a small number of births and abortions among women younger than 15 years of age, the age group 15-19 was still used as a denominator in accordance with international practice.[26] We also stratified the birth and abortion rates into the age groups 13-14, 15-17 and 18-19 years.

In Sweden the collection of abortion data was temporarily stopped in 2013. When the collection started again in 2014, only data for 5-year-intervals of age were available, thus we were not able to retrieve data for the sub-groups of 13-14, 15-17 and 18-19 year-olds from 2013 and onwards.

The proportion of pregnancies ending with an abortion was estimated by using the number of abortions as numerator and the sum of abortions and births as denominator. Miscarriages and ectopic pregnancies were not included.

National data on redeemed prescriptions of hormonal contraceptives in the Nordic countries were collected from the Danish National Registry of Medicinal Product Statistics, [27] the Norwegian Prescription Database[28] and the National Board of Health and Welfare in Sweden.[25] The collected data provides information on sold packages or items of different types of contraceptives expressed as defined daily doses (DDD). Use of combined oral contraceptives (COC), progestogen-only pills (POP), the

contraceptive patch, the vaginal ring and the injection were expressed as DDD per 100 women-years (%). To be able to compare the levonorgestrel-releasing intrauterine system (LNG-IUS) with the other contraceptive methods, the mean duration of use for the two LNG-IUSs available during the study period were set to four [29] and two years, respectively.[30] Similarly, we calculated duration of use for the etonogestrel implant to be two years according to the average duration of use reported in previous studies. [29 31] All prescribed hormonal contraceptives to women  $\leq 19$  years of age were included when user rates among 15-19-year-olds were described, although a small number of prescriptions were for women below 15 years of age. As for abortion and birth rates, we also estimated hormonal contraceptive user rates for the age groups 13-14, 15-17 and 18-19 years.

Use of copper-IUD, condoms, diaphragms and fertility awareness methods were not estimated since these methods are not registered in any national data bases. Since personal identification data is not recorded for hormonal emergency contraceptives these methods are not included either.

Since all variables were collected on a group level from anonymised data including all teenagers, also teenagers who were infertile, not heterosexually active, pregnant or wished to get pregnant were also included in the study population.

Demographic data for the Nordic countries were obtained from the database *Facts about the Nordic region*. [32]

### **Patients' involvement and ethical considerations**

The legal aspects of utilization of registry data for study purposes in Denmark and Norway were performed in accordance with national legislation. For Norway, the board of the Norwegian Prescription Database reviewed the protocol and gave permission for use of the data. Studies using anonymous data from nationwide registers are by Norwegian legislation exempted from the need of institutional regulatory board approvals and written informed consent from the patients. The specific permissions from the relevant body were in Denmark achieved from Datatilsynet (journal no [2010-41-4778](#)).

In Finland, Iceland and Sweden no permission was required as these data are publicly available from the national bodies of these countries. Patients were not directly



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involved in the study since only aggregated data on group-level was used. No ethical consent was therefore needed.

**Statistical methods**

In these purely descriptive analyses, no confidence intervals were calculated for the country specific rates. Since all female teenagers in each specific age group were included even small differences were highly significant.

**RESULTS**

**Population**

When overall birth and abortion rates were estimated the population consisted of all 15-19 years old women in all the Nordic countries (n = 749 709 individuals in 2015). When subgroup analyses were made for births, abortions and hormonal contraceptive user rates all 13-19 years old women in Denmark, Norway and Sweden were included (n = 815 044 individuals in 2015).

**Overall birth and abortion rates among teenager 15-19 years, 1975-2015**

Figure 1a shows a continuous decline in the birth rates among teenagers in all the Nordic countries from 1975 to 2015. The steepest decline was seen in Norway from 40 to 5 per 1000 teenagers and in Iceland from 38 to 8 per 1000 teenagers. The abortion rates varied and some fluctuations were seen in all countries until ~1999. From 2000 and onwards all countries had a steady decline. The abortion rates fell from 26 to 11 in Denmark, 21 to 8 in Finland, 17 to 13 in Iceland, 20 to 8 in Norway and 29 to 14 per 1000 teenagers in Sweden (Figure 1b). Both birth and abortion rates decreased which resulted in an overall decline of teenage pregnancy rate in all countries. The proportion of pregnancies ending with an abortion increased in all countries until ~year 2003 and after that the levels have been relatively stable on 60-80% (Figure 1c). The highest proportions were seen in Denmark and Sweden.

**Overall hormonal contraceptive use among teenagers 15-19 years, 2008-2015**

The overall use of hormonal contraceptives went from 51% to 47% in Denmark, 37% to 41% in Norway and 39% to 42% in Sweden from 2008 through 2015 (Fig.2). COC was

the most commonly used contraceptive method in all countries, but more frequently used among Danish teenagers, while POP were more common in Sweden (7 to 5%) and Norway (3 to 4%). The use of contraceptive implant was more popular in Norway (1 to 6%) and Sweden (4 to 6%) than in Denmark (2%) and the use of the LNG-IUS increased from 1 to 7% in Sweden, 0,5 to 2% in Denmark and 0,5 to 1% in Norway.

### **Age-stratified use of hormonal contraceptives, births and abortions in Denmark, Norway and Sweden, 2008-2015**

The use of hormonal contraceptives over the years 2008 through 2015 was very low among 13-14 year-old teenagers in all three countries (from 5 to 3% in Denmark, 1% in Norway and from 1 to 2% in Sweden). The birth and abortion rates were also very low in this age group. Births varied between 0 and 0,1 per 1000 teenagers a year in all three countries. Abortion rates varied between 1,7-0,5 in Denmark, 0,3-0,4 in Norway and 1,9 -1,3 per 1000 teenagers in Sweden (during 2008-2012 in Sweden, no data available 2013-2015) (Fig.3a).

Denmark had a markedly higher use of hormonal contraceptives among 15-17-year-olds (from 40 to 34%) than Norway (from 25 to 27%) and Sweden (from 29 to 30%). The birth rates varied around 2 per 1000 teenagers yearly in all three countries. The abortion rates in the same age group declined from 12 to 6 in Denmark, 8 to 4 in Norway and 17 to 12 per 1000 teenagers in Sweden (during 2008-2012 in Sweden, no data available 2013-2015). (Fig.3b)

The user rates of hormonal contraceptives among teenagers 18-19 years of age went from 63 to 61% in Denmark, 56 to 61% in Norway and 54 to 56% in Sweden. A more marked decrease of the birth rate was seen among 18-19-year-olds in Norway (from 20 to 10 per 1000 teenagers) compared to the other two countries (from 13 to 7 in Denmark and from 12 to 9 in Sweden), where Norway started off on a higher level in 2008 (Fig. 3c). The abortion rates in the same age group declined from 26 to 18 per 1000 in Denmark, from 25-14 in Norway and 33 to 26 per 1000 teenagers in Sweden (during 2008-2012 in Sweden, no data available 2013-2015).

Combined hormonal contraceptives (CHC) were the most popular contraceptive methods in all age groups, especially among the Danish teenagers. There was an increase from 2 to 11% in the use of the LNG-IUS among the Swedish 18-19 -year-olds.

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225 The use of implants increased among Norwegian 18-19 -year-olds from 1 to 7%. During  
226 the same period POP and CHC use decreased to some extent. (Figure 3a-c).

227 **DISCUSSION**

228 Birth and abortion rates among teenagers have declined steadily from 1975 and  
229 onwards in all the Nordic countries. During the period 2008-2015 more than half of the  
230 18-19-year-old women were using hormonal contraception. The use of long-acting  
231 reversible contraception (LARC) increased while there was a small reduction in the use  
232 of CHC and POP.

233 Birth and abortion rates were low in the Nordic countries compared to overall  
234 worldwide rates among teenagers.[12] Moreover, the decreasing rate of teenage births  
235 has not been offset by an increasing abortion rate. This indicates high fertility  
236 awareness, and effective prevention of unplanned pregnancies by the use of highly  
237 effective contraceptive methods.

238 The strength of this study was the use of national register data, which included all  
239 adolescents in the Nordic countries. All the registries are considered reliable. However  
240 redeemed prescriptions do not necessarily mean that the contraceptives actually have  
241 been used. Nevertheless, when assessing contraceptive use, pharmacy claims have been  
242 shown to be more reliable than self-reported use, as women tend to overestimate their  
243 contraceptive use.[33] Online purchases of pharmaceutical drugs without a registered  
244 prescription are not included in the study. Since prescribed hormonal contraceptives are  
245 available and affordable to most adolescents in the Nordic countries, the proportion of  
246 online purchases without a prescription is not considered to be significant. A limitation  
247 in this study was the lack of age specific data on contraceptive use from Finland and  
248 Iceland.

249 Although declining, Sweden had the highest teenage abortion rate and the reasons for  
250 that are not obvious. The observed differences in overall user rates of hormonal  
251 contraceptives could not explain the differences in abortion rates since e.g. Norway had  
252 a lower user rate than Sweden, but still had lower abortion rates.

253 The risk of unplanned pregnancies is determined by three main factors; the proportion  
254 of sexually active women in the studied age group, the proportion of women using any  
255 contraceptive method and the quality of the contraceptive use.

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257 Concerning sexual activity a study including 65 000 women in Denmark, Iceland,  
258 Norway and Sweden showed that the number of sexual partners and median age for first  
259 intercourse (16 years) was the same in all the countries.[34] Thus there is little evidence  
260 to suggest that differences in sexual activity can explain the differences in the abortions  
261 rates between the Nordic countries.

262 Regarding the second identified factor, proportion of contraceptive users, there were  
263 only small differences between the three Nordic countries studied and the proportion  
264 did not increase more in countries with the steepest decrease in births and abortion  
265 rates. The timing of initiation of contraceptive use might play a role though since it has  
266 been shown that initiation before or at first intercourse is associated with lower future  
267 abortion rates compared to initiation after the first intercourse.[35] We were not able to  
268 estimate the proportion of women using other methods such as copper-IUDs, condoms  
269 fertility awareness methods and emergency contraceptives. According to national[14  
270 16 36] and European studies[18 37], condoms are a frequently used contraceptive  
271 method among teenagers with pronounced user dependent efficacy. There might be  
272 differences in condom use between the Nordic countries that can influence the  
273 pregnancy rates.

274 The third important factor is the quality of the contraceptive use. There is robust  
275 scientific evidence of the high efficacy of LARC methods [38 39]. During the last 10-15  
276 years the promotion of LARC as the most effective form of contraception has increased  
277 and it has been reflected in e.g. national guidelines on contraception. This  
278 recommendation also applies to teenagers. Both Norwegian, Swedish, and to a lesser  
279 extent, Danish teenagers have increased their use of LARC (including LNG-IUS and  
280 implants) at the expense of CHC and POP during the most recent years. There was a shift  
281 towards recommending LARC already in the guidelines for contraception in 2005 in  
282 Sweden but in the updated guidelines from 2014 LARC was strongly recommended as a  
283 first option also for teenagers. Norway has done similar recent updates. In 2014 also a  
284 smaller LNG-IUS (Jaydess®) was introduced on the market as an IUS especially well  
285 suited for young women. It is likely that these actions are at least some of the reasons for  
286 the increasing use of LARC seen in this study, especially among 18-19 year-old women,

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3 287 and the steady and on-going decline of the abortions rates which have now reached  
4 288 their all-time-low mark.  
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9 290 Sexual activity, contraceptive user rate and the quality of the contraceptive use can be  
10 291 influenced by a number of factors. Simultaneously with the liberalisation of the abortion  
11 292 laws in the 1970's the Nordic countries also focused on easy access to contraceptives,  
12 293 establishment of family planning services, youth clinics and sexuality education  
13 294 programmes. The implementation of these routines differed to some extent between  
14 295 countries. To ensure easy access to contraceptives GPs in Denmark and Norway were  
15 296 given the main responsibility for prescribing contraceptives. In Sweden midwives have  
16 297 been the main prescriber since the 70s. Unfortunately they have to a great extent been  
17 298 left without medical advisors, which might influence their recommendations of  
18 299 contraceptives. For instance, the relatively high use of POP shown in this study in  
19 300 Sweden might be due to the fact that there are fewer contraindications for POP than CHC  
20 301 and without the necessary medical support it is safer to prescribe POP than CHC  
21 302 although POP has a lower continuation rate. [40]  
22  
23 303 Sexuality education programmes have been suggested to lower teenage pregnancy rates  
24 304 by postponing the first sexual intercourse and by increasing both contraceptive user  
25 305 rates and quality of use.[41] All the Nordic countries have compulsory sexuality  
26 306 education in schools but Finland has the most extensive programme of all the countries.  
27 307 Finland, with the current lowest abortion rate among the Nordic countries, witnessed an  
28 308 increase in the abortion rate in the mid-1990's just after the programme were no longer  
29 309 considered mandatory. After reinstituting a comprehensive compulsory sexuality  
30 310 education programme again in all Finnish schools in the early 2000's, the abortion rate  
31 311 dropped again. [42] In Finland the programme is part of the specific school subject  
32 312 "Health science" taught only by qualified teachers, in contrast to the other Nordic  
33 313 countries where sexuality education can be integrated in any other school subject and  
34 314 has a less well-defined curriculum.  
35  
36 315 Subsidies of contraceptives have been suggested to lower pregnancy rates. However,  
37 316 Denmark, without any subsidies at all has a higher contraceptive user rates and a lower  
38 317 abortion rate than Sweden, which offers subsidies for young women. On the other hand,  
39 318 in the CHOICE study where subsidies were combined with an extensive promotion of

LARC in the St Louis area of the USA, the teenage pregnancy rate did decrease.[43] Also in Sweden there have been temporary and regional declines in abortion rates when local subsidies have been launched together with promotion campaigns for e.g. LARC, but the impact on the overall and long-term abortion rate has been difficult to detect. In 2002 Norway introduced on a national level its subsidy of COC to teenagers 16-19 years of age and in 2006 it was expanded to partly fund all hormonal contraceptive methods for teenagers, except LNG-IUS. A strength of the Norwegian subsidy system compared to the Swedish is probably that it is nationwide.

In conclusion, we report steadily declining teenage birth and abortion rates and a high user rate of hormonal contraceptives in all the Nordic countries with an increase of LARC during the most recent years. A multifactorial approach to ensure easy access to and high level of knowledge among teenagers about contraception has played a major role to achieve the results of teenage pregnancy prevention. Of the pregnancies that still occur among teenagers in the Nordic countries one could assume that some are actually planned. However, it is still possible to further lower the rates of unplanned pregnancies. Thus, interventions that increase the availability and knowledge of highly effective contraceptives should be given high priority in order to reach teenagers who are sexually active, but not using any contraceptives or are relying on methods with low efficacy.

#### **CONTRIBUTORSHIP**

HH, FES, OH, KGD, IM, OL and IL developed the study design. HH, IL, FES, OH and OL collected the data and HH, FES, OH, KGD, IM, OL and IL analysed the data. The first draft of the manuscript was prepared by HH and IL. and FES, OH, KGD, IM, OL contributed in a critical discussion regarding the final manuscript. HH, FES, OH, KGD, IM, OL and IL had access to the data and approved of the final version of the manuscript submitted.

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**COMPETING INTERESTS**

All authors have completed the Unified Competing Interest form at [www.icmje.org/coi.disclosure.pdf](http://www.icmje.org/coi.disclosure.pdf) (available on request from the corresponding author) and declare that IL has received compensation from Bayer AG, MSD and Actavis for lectures and participation in an Advisory Board during the previous three years; FES – has over the past three years nothing to disclose; KGD has served ad hoc on advisory boards or as invited speaker for Bayer AG, Merck/MSD, Actavis, HRA-Pharma, Exelgyn, Mithra, NaturalCycles and Gedeon Richter; OH has served ad hoc on advisory boards or as invited speaker for Bayer AG, MSD, Actavis, Exelgyn, Sandoz and Gedeon Richter; HH has had no relationships with any company in the previous three years; IM has served ad hoc on advisory boards or as invited speaker for Bayer AG, Gedeon Richter and Actavis during the previous three years; ØL has within the last three years received honoraria for presentation/lectures in pharmacoepidemiologic issues. For all authors, their spouses, partners or children have no financial interests that may be relevant to the submitted work.

**DATA SHARING**

Aggregated data from national registries used in the study are available at reasonable request from the corresponding author. Consent for data sharing was not obtained, but the presented data are anonymous and there is no risk for identification of individual patients.

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**FIGURE LEGENDS**

**Figure 1a-c.** Births, abortions and the proportion of pregnancies ending with abortion among teenagers (15-19 years of age) in the Nordic countries 1975-2015

**Figure 2.** Contraceptive use, birth and abortion rates among teenagers (15-19 years of age) in Denmark, Norway and Sweden 2008-2015.

**Figure 3a-c.** Contraceptive use, birth and abortion rates among teenagers (13-19 years of age) in Denmark, Norway and Sweden 2008-2015 according to age groups. Please note the different scales.

Figure 1 a-c

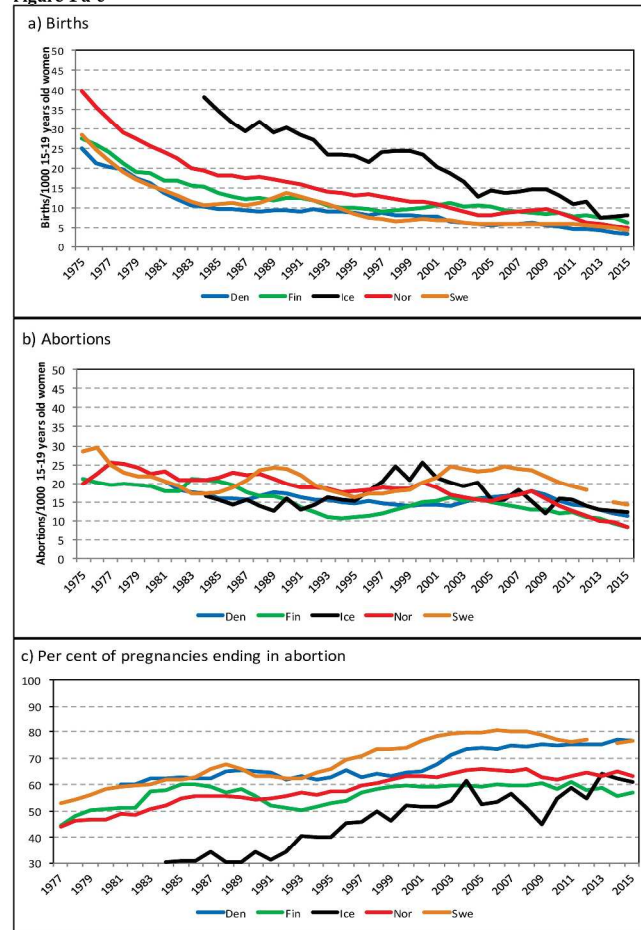
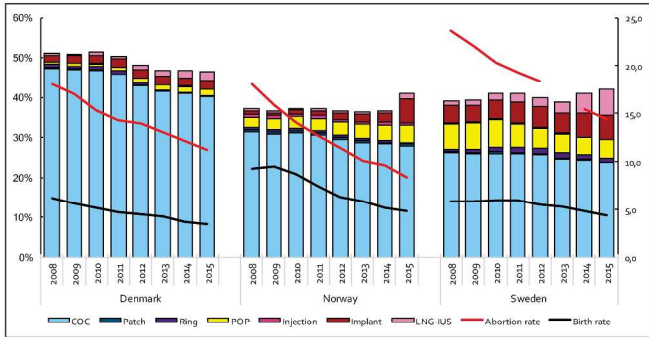


Figure 1a-c. Births, abortions and the proportion of pregnancies ending with abortion among teenagers (15-19 years of age) in the Nordic countries 1975-2015

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**Figure 2.** Contraceptive use, birth and abortion rates among teenagers (15-19 years of age) in Denmark, Norway and Sweden 2008-2015.

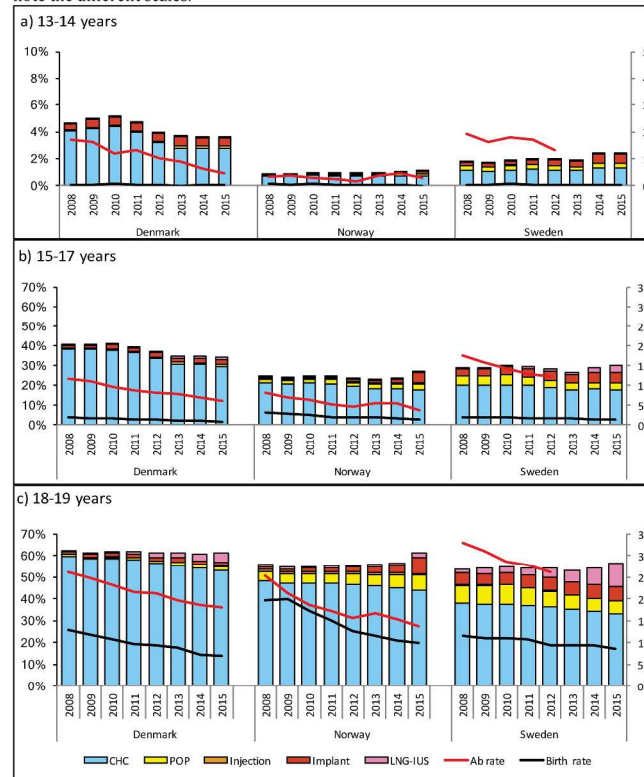


Y1 (left): Use of hormonal contraception (%). Y2 (right): Birth and abortion rates (number of women/1000 women and year).  
Age-stratified abortion rates were not available for 2013 for Sweden.  
CHC = combined hormonal contraception (subgroups oral, vaginal and transdermal);  
POP = middle or low dose progestogen-only pill; Injection = depot medroxyprogesterone acetate (DMPA); LNG-IUS = levonorgestrel-releasing intrauterine system

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Y1 (left): Use of hormonal contraception (%). Y2 (right): Birth and abortion rates (number of abortion or births/1000 women). Please note the different scales. Age-stratified abortion rates were not available for 2013-15 for Sweden. CHC = combined hormonal contraception (subgroups oral, vaginal and transdermal); POP = middle or low dose progestogen-only pill; Injection = depot medroxyprogesterone acetate (DMPA); LNG-IUS = levonorgestrel-releasing intrauterine system, ab rate = abortion rate

Figure 3a-c. Contraceptive use, birth and abortion rates among teenagers (13-19 years of age) in Denmark, Norway and Sweden 2008-2015 according to age groups. Please note the different scales.

297x420mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5,6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5,6
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5,6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	n.a.
		(c) Explain how missing data were addressed	n.a.
		(d) If applicable, describe analytical methods taking account of sampling strategy	n.a.
		(e) Describe any sensitivity analyses	n.a.
Results			



Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	n.a.
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	n.a.
		(b) Indicate number of participants with missing data for each variable of interest	n.a.
Outcome data	15*	Report numbers of outcome events or summary measures	7-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n.a.
		(b) Report category boundaries when continuous variables were categorized	n.a.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n.a.
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).



# BMJ Open

## An ecological study on the use of hormonal contraception, abortions and births among teenagers in the Nordic countries

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Secondary Subject Heading:	Epidemiology
Keywords:	Teenagers, Hormonal contraception, Births, Abortions, Contraceptive use

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**1 An ecological study on the use of hormonal contraception,**  
**2 abortions and births among teenagers in the Nordic countries**

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4 Running title: Hormonal contraception, abortions and births among teenagers in the  
5 Nordic countries  
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27 Word count: 3626

## ABSTRACT

**Objectives:** Compare hormonal contraceptive use, birth and abortion rates among teenagers in the Nordic countries. A secondary aim was to explore plausible explanations for possible differences between countries.

**Design:** Ecological study utilising National registry data concerning abortions and births among all women aged 15-19 years resident in Denmark, Finland, Iceland, Norway and Sweden 2008-2015. Age specific data on prescriptions for hormonal contraceptives for the period 2008-2015 were obtained from national databases in Denmark, Norway, and Sweden.

**Setting:** Denmark, Finland, Iceland, Norway and Sweden.

**Participants:** Women 15-19 years old in all Nordic countries (749 709) and 13-19 years old in Denmark, Norway and Sweden (815 044).

**Results:** Both annual birth rates and abortion rates fell in all the Nordic countries during the study period. The highest user rate of hormonal contraceptives among 15-19 year olds was observed in Denmark (from 51 to 47%) followed by Sweden (from 39 to 42%) and Norway (from 37 to 41%). Combined oral contraceptives were the most commonly used methods in all countries. The use of long-acting reversible contraceptives (LARC), implants and the levonorgestrel-releasing intrauterine systems, were increasing, especially in Sweden and Norway. In the subgroup of 18-19 years old teenagers the user rates of hormonal contraceptives varied between 63 to 61% in Denmark, 56 to 61% in Norway and 54 to 56% in Sweden. In the same subgroup the steepest increase of LARC was seen in, where the use of LARC increased from 2 to 6% in Denmark, 2 to 9% in Norway and 7 to 17% in Sweden.

**Conclusions:** Birth and abortion rates continuously declined in the Nordic countries among teenagers. There was a high user rate of hormonal contraceptives, with an increase in the use of LARC especially among the oldest teenagers.

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**STRENGTHS AND LIMITATIONS OF THIS STUDY**

- The main strength of this study was the use of national register data, including all adolescents in the Nordic countries.
- In this study data on redeemed prescriptions has been used since it has been shown to be more reliable than self-reported use of contraceptives.
- Non-hormonal contraceptives are not registered in any of the national databases and hence were not included in this study.
- Since personal identification data is not recorded for contraceptive sales in Finland and Iceland, use of hormonal contraceptives were only available from Denmark, Norway and Sweden.

**TRIAL REGISTRATION NUMBER:** Not applicable

**KEY WORDS:** Teenagers; Contraceptive use; Abortion; Births; Hormonal contraception

**ABBREVIATIONS:**

COC –Combined oral contraception, CHC –Combined hormonal contraception, POP Progestogen only pill, LARC –Long-acting Reversible Contraception, LNG-IUS –Levonorgestrel-releasing intrauterine system

## 71 INTRODUCTION

72 Teenage pregnancy is regarded as a challenge both to society and the teenager.[1]  
73 Adolescent pregnancy and motherhood is associated with low socioeconomic status,  
74 early school leaving, and poor health of the mother during and after pregnancy.[2-6].  
75 Also the child of a teenage mother is at risk both during the perinatal period and in the  
76 long-term.[2] Socioeconomic deprivation is considered to be both an effect of and a risk  
77 factor for teenage births. Hence ill-health and low socioeconomic status are often  
78 disseminated across generations.[6 7] Women experiencing teenage motherhood or  
79 teenage abortion are also at risk of having another unplanned pregnancy. [8-10]  
80 In the United States and Europe the rates of teenage pregnancies are declining [11], but  
81 there is a large variation both between the United States and Europe, and within the  
82 European continent.[12] The outcome of pregnancies differs greatly, where in some  
83 regions most of the teenage pregnancies end with an induced abortion, while in others a  
84 pregnancy is usually continued to term. Although the United States has witnessed a  
85 steadily declining teenage pregnancy rate (57/1000 in 2011), it is still comparable to the  
86 highest rates seen in the east-European countries. For example, an incidence of 60/1000  
87 of adolescent pregnancy has recently been reported from Romania and Bulgaria.[12] In  
88 Northern Europe pregnancy rates vary between high levels of pregnancies and births in  
89 England and Wales (47/1000 in 2011) and much lower overall pregnancy rates in the  
90 Nordic countries and Ireland.[12-14]  
91 The declining rate of teenage pregnancy in the Nordic countries has been documented in  
92 several studies.[15-17] It has been suggested that an increasing availability of  
93 contraceptives is one of the reasons for the decline. Patterns of contraceptive use among  
94 teenagers have been described in individual Nordic countries [16 18 19] and as part of  
95 European surveys. [20 21] However, recent and comprehensive studies, including data  
96 on both pregnancies and contraceptive use among all Nordic teenagers, are lacking.  
97 The aim of this study was to compare hormonal contraceptive use, birth and abortion  
98 rates among teenagers in the Nordic countries. A secondary aim was to explore  
99 plausible explanations for possible differences between countries.

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**MATERIAL AND METHODS**

National data on abortion and birth rates among teenagers were compiled from the five Nordic countries Denmark, Finland, Iceland, Norway and Sweden from 2008 to 2015. Data regarding the use of hormonal contraceptives for the period 2008-2015 were only available from Denmark, Norway and, Sweden as personal identification data is not recorded for contraceptive sales in Finland and Iceland. Information on birth and abortion rates were collected from the National Health Registries[22] and the Tigrab Database[23] in Denmark, The National Institute for Health and Welfare in Finland [24], the Directorate of Health in Iceland,[25] the Norwegian Institute of Public Health[26] and the National Board of Health and Welfare in Sweden.[27] Birth and abortion rates were expressed as the number of births or abortions/1000 women and year in a certain age group according to international practice. When displaying the overall teenage birth and abortion rates, all births or abortions during one year among women ≤19 years of age were included. Even though there is a small number of births and abortions among women younger than 15 years of age, the age group 15-19 was still used as a denominator in accordance with international practice.[28] Age was further categorised into three groups (13-14, 15-17 and 18-19 years). In Sweden the collection of abortion data was temporarily stopped in 2013. When collection started again in 2014, only data for 5-year-intervals of age were available, thus Sweden was not able to provide data for the sub-groups of 13-14, 15-17 and 18-19 year-olds from 2013 and onwards. National data on redeemed prescriptions of hormonal contraceptives in the Nordic countries were collected from the Danish National Registry of Medicinal Product Statistics, [29] the Norwegian Prescription Database[30] and the National Board of Health and Welfare in Sweden.[27] The collected data provides information on sold packages or items of different types of contraceptives expressed as defined daily doses (DDD). Use of combined oral contraceptives (COC), progestogen-only pills (POP), the contraceptive patch, the vaginal ring and the injection were expressed as DDD per 100 women-years (%). To be able to compare the levonorgestrel-releasing intrauterine system (LNG-IUS) with the other contraceptive methods, the mean duration of use for the two LNG-IUSs available during the study period were set to four [31] and two years,

respectively.[32] Similarly, we calculated duration of use for the etonogestrel implant to be two years according to the average duration of use reported in previous studies. [31 33] All prescribed hormonal contraceptives to women  $\leq 19$  years of age were included when user rates among 15-19-year-olds were estimated, although a small number of prescriptions were for women below 15 years of age. As for abortion and birth rates, we also estimated hormonal contraceptive user rates for the age groups 13-14, 15-17 and 18-19 years.

Use of copper-IUD, condoms, diaphragms and fertility awareness methods were not estimated since these methods are not registered in any national data bases. Since personal identification data is not recorded for hormonal emergency contraceptives these methods are not included either.

Since all variables were collected on a group level from anonymised data including all teenagers, also teenagers who were infertile, not heterosexually active, pregnant or wished to get pregnant were part of the study population.

Demographic data for the Nordic countries were obtained from the database *Facts about the Nordic region*. [34]

### **Ethical considerations**

All data included in the study was either already in the public domain or anonymised on receipt.

The legal aspects of utilization of registry data for study purposes in Denmark and Norway were performed in accordance with national legislation. For Norway, the board of the Norwegian Prescription Database reviewed the protocol and gave permission for use of the data. Studies using anonymous data from nationwide registers are by Norwegian legislation exempted from the need of institutional regulatory board approvals and written informed consent from the patients. The specific permissions from the relevant body were in Denmark achieved from Datatilsynet (journal no [2010-41-4778](#)).

In Finland, Iceland and Sweden no permission was required as these data are publicly available from the national bodies of these countries. Since patients were not directly involved in the study and only anonymised data was used no ethical consent was needed.

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**Patient and public involvement**

There was no direct involvement in the study by patients, since only aggregated and anonymised data were used.

**Statistical methods**

In these purely descriptive analyses, no confidence intervals were calculated for the country specific rates. Since all female teenagers in each specific age group were included even small differences were highly significant.

**RESULTS**

**Population**

In 2015 the overall study population comprised 749 709 women 15-19 years old in the Nordic countries. When restricting the analysis to 13-19 years old women in Denmark, Norway and Sweden the study population comprised 815 044 teenagers (2015).

**Use of hormonal contraception, births and abortions among teenagers 15-19 years, 2008-2015**

The overall use of hormonal contraceptives varied between 51% to 47% in Denmark, 37% to 41% in Norway and 39% to 42% in Sweden from 2008 through 2015 (Figure 1a and b). COC was the most commonly used contraceptive method in all countries, but more frequently used among Danish teenagers, while POP were more common in Sweden (7 to 5%) and Norway (3 to 4%). The use of LARC, including implants and the LNG-IUS increased from 2 to 4% in Denmark, 1 to 7% in Norway and 5 to 12% in Sweden. In Sweden and Denmark the increase of LARC consisted mainly of a higher use of LNG-IUS, In Norway there was no increase in the use of LNG-IUS, but the use of implants increased from 1 to 6%.

The birth rates fell from 6 to 3/1000 women 15-19 years in Denmark, 9 to 6 in Finland, 15 to 8 in Iceland, 9 to 5 in Norway and 6 to 4 in Sweden (Figure 1a and b. Finland and Iceland are not included in the figure).



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3 193 The abortion rates fell from 18 to 11/1000 in women aged 15-19 years in Denmark, 13  
4 194 to 8 in Finland, 15 to 13 in Iceland, 18 to 8 in Norway and 24 to 14 per 1000 teenagers in  
5 195 Sweden (Figure 1a and b. Finland and Iceland are not included in the figure). Both birth  
6 196 and abortion rates decreased which resulted in an overall decline of teenage pregnancy  
7 197 rates in all countries.

11 198 **Age-stratified use of hormonal contraceptives, births and abortions in Denmark,**  
12 199 **Norway and Sweden, 2008-2015**

15 200 The use of hormonal contraceptives over the years 2008 through 2015 was very low  
16 201 among 13-14 year-old teenagers in all three countries (from 5 to 3% in Denmark, 1% in  
17 202 Norway and from 1 to 2% in Sweden). The birth and abortion rates were also very low  
18 203 in this age group. Births varied between 0 and 0.1 per 1000 teenagers a year in all three  
19 204 countries. Abortion rates varied between 1.7-0.5 in Denmark, 0.3-0.4 in Norway and 1.9  
20 205 -1.3 per 1000 teenagers in Sweden (during 2008-2012 in Sweden, no data available  
21 206 2013-2015) (Figure 2a and Figure 3a).

27 207 Denmark had a markedly higher use of hormonal contraceptives among 15-17-year-olds  
28 208 (from 40 to 34%) than Norway (from 25 to 27%) and Sweden (from 29 to 30%).  
29 209 Combined hormonal contraception (CHC) were the most commonly used method in all  
30 210 countries. Use of LARC, including implants and LNG-IUS, increased from 2 to 3% in  
31 211 Denmark, 1 to 6% in Norway and 4 to 9% in Sweden. Birth rates varied around 2 per  
32 212 1000 teenagers yearly in all three countries. The abortion rates in the same age group  
33 213 declined from 12 to 6 in Denmark, 8 to 4 in Norway and 17 to 12 per 1000 teenagers in  
34 214 Sweden (during 2008-2012 in Sweden, no data available 2013-2015). (Figure 2b and  
35 215 Figure 3b)

42 216 The overall user rates of hormonal contraceptives among teenagers 18-19 years of age  
43 217 varied between 63 to 61% in Denmark, 56 to 61% in Norway and 54 to 56% in Sweden.  
44 218 CHC were the most commonly used method in all countries. Use of LARC, including  
45 219 implants and LNG-IUS, increased from 2 to 6% in Denmark, 2 to 9% in Norway and 7 to  
46 220 17% in Sweden. A more marked decrease of the birth rate was seen among 18-19-year-  
47 221 olds in Norway (from 20 to 10 per 1000 teenagers) compared to the other two countries  
48 222 (from 13 to 7 in Denmark and from 12 to 9 in Sweden), where Norway started off on a  
49 223 higher level in 2008 (Figure 2c and Figure 3c). The abortion rates in the same age group

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3 224 declined from 26 to 18 per 1000 in Denmark, from 25-14 in Norway and 33 to 26 per  
4 225 1000 teenagers in Sweden (during 2008-2012 in Sweden, no data available 2013-2015).  
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9 227 **DISCUSSION**

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11 228 Birth and abortion rates among teenagers in all the Nordic countries have declined  
12 229 between 2008 and 2015. During the same time period more than half of the 18-19-year  
13 230 old women were using hormonal contraception. The use of long-acting reversible  
14 231 contraception (LARC) increased, especially among 18-19 year olds, while there was a  
15 232 small reduction in the use of CHC and POP. Birth and abortion rates were low in the  
16 233 Nordic countries compared to overall worldwide rates among teenagers.[12] Moreover,  
17 234 the decreasing rate of teenage births has not been offset by an increasing abortion rate.

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19 235 The strength of this study was the use of national register data, which included all  
20 236 adolescents in the Nordic countries. All the registries are considered reliable. However  
21 237 redeemed prescriptions do not necessarily mean that the contraceptives actually have  
22 238 been used. Nevertheless, when assessing contraceptive use, pharmacy claims have been  
23 239 shown to be more reliable than self-reported use, as women tend to overestimate their  
24 240 contraceptive use.[35] Online purchases of pharmaceutical drugs without a registered  
25 241 prescription are not included in the study. Since prescribed hormonal contraceptives are  
26 242 available and affordable to most adolescents in the Nordic countries, the proportion of  
27 243 online purchases without a prescription is not considered to be significant. A limitation  
28 244 in this study was the lack of age specific data on contraceptive use from Finland and  
29 245 Iceland.

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31 246 Although declining, Sweden had the highest teenage abortion rate and the reasons for  
32 247 that are not obvious. The observed differences in overall user rates of hormonal  
33 248 contraceptives could not explain the differences in abortion rates since e.g. Norway had  
34 249 a lower user rate than Sweden, but still had lower abortion rates.

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36 250 The risk of unplanned pregnancies is determined by three main factors; the proportion  
37 251 of sexually active women in the studied age group, the proportion of women using any  
38 252 contraceptive method and the efficacy of the contraceptive used.

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254 Concerning sexual activity a study including 65 000 women in Denmark, Iceland,  
255 Norway and Sweden reported that the number of sexual partners and median age for  
256 first intercourse (16 years) was the same in all countries.[36] However the study only  
257 covers the years 2004-2005. The declining pregnancy rate seen in all the Nordic  
258 countries during the study period could be due to postponed time of first intercourse  
259 and/or declining sexual activity among teenagers, but there is no recent studies to  
260 support or reject this statement.

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262 Regarding the second identified factor, proportion of contraceptive users, there were  
263 only small differences between the three Nordic countries studied and the proportion  
264 did not increase more in countries with the steepest decrease in births and abortion  
265 rates. The timing of initiation of contraceptive use might play a role though since it has  
266 been shown that initiation before or at first intercourse is associated with lower future  
267 abortion rates compared to initiation after the first intercourse.[37] We were not able to  
268 estimate the proportion of women using other methods such as copper-IUDs, condoms,  
269 fertility awareness methods and emergency contraceptives. According to national[16  
270 18 38] and European studies[20 39], condoms are a frequently used contraceptive  
271 method among teenagers with pronounced user dependent efficacy. There might be  
272 differences in condom use between the Nordic countries that can influence the  
273 pregnancy rates.

274 The third important factor is the quality of the contraceptive use. There is robust  
275 scientific evidence of the high efficacy of LARC methods [40 41]. During the last 10-15  
276 years the promotion of LARC as the most effective form of contraception has increased  
277 and it has been reflected in e.g. national guidelines on contraception. This  
278 recommendation also applies to teenagers. Both Norwegian, Swedish, and to a lesser  
279 extent, Danish teenagers have increased their use of LARC (including LNG-IUS and  
280 implants) at the expense of CHC and POP during the most recent years. There was a shift  
281 towards recommending LARC already in the guidelines for contraception in 2005 in  
282 Sweden but in the updated guidelines from 2014 LARC was strongly recommended as a  
283 first option also for teenagers. Norway has made similar recent updates for  
284 recommendations of LARC. In 2014 also a smaller LNG-IUS (Jaydess®) was introduced  
285 on the market as an IUS especially well suited for young women. It is likely that these

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3 286 actions are at least some of the reasons for the increasing use of LARC seen in this study,  
4 287 especially among 18-19 year-old women. During the same period of time abortion rates  
5 288 in all the countries included in this study have reached their all-time-low mark.  
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10 290 Sexual activity, contraceptive user rate and the quality of the contraceptive use can be  
11 291 influenced by a number of factors. Simultaneously with the liberalisation of the abortion  
12 292 laws in the 1970's the Nordic countries also focused on easy access to contraceptives,  
13 293 establishment of family planning services, youth clinics and sexuality education  
14 294 programmes. The implementation of these routines differed to some extent between  
15 295 countries. To ensure easy access to contraceptives GPs in Denmark and Norway were  
16 296 given the main responsibility for prescribing contraceptives, although since 2006 public  
17 297 health nurses and midwives has also been granted authorisation to prescribe hormonal  
18 298 contraceptives. In Sweden midwives have been the main prescriber since the 70s.  
19 299 Unfortunately they have to a great extent been left without medical advisors, which  
20 300 might influence their recommendations of contraceptives. For instance, the relatively  
21 301 high use of POP shown in this study in Sweden might be due to the fact that there are  
22 302 fewer contraindications for POP than CHC and without the necessary medical support it  
23 303 is safer to prescribe POP than CHC although POP has a lower continuation rate. [42]  
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25 304 Sexuality education programmes have been suggested to lower teenage pregnancy rates  
26 305 by postponing the first sexual intercourse and by increasing both contraceptive user  
27 306 rates and quality of use. There is however a wide variety of programmes and from the  
28 307 studies it is difficult to draw conclusions about which type of of programme that actually  
29 308 might have an impact on teenage pregnancy rates.[43] A Cochrane review of school-  
30 309 based sexuality education programmes found no evidence of an impact on pregnancy  
31 310 rates. There was however a low grade of evidence for an impact of incentives to stay in  
32 311 school on lower pregnancy rates. It should be noted that the majority of the studies  
33 312 included in the review were from low to middle-income countries.[44] All the Nordic  
34 313 countries have compulsory sexuality education in schools but Finland has the most  
35 314 extensive programme of all the countries. Finland, with the current lowest abortion rate  
36 315 among the Nordic countries, witnessed an increase in the abortion rate in the mid-  
37 316 1990's just after the programme were no longer considered mandatory. After  
38 317 reinstituting a comprehensive compulsory sexuality education programme again in all

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3 318 Finnish schools in the early 2000's, the abortion rate dropped again. [45] In Finland the  
4 319 programme is part of the specific school subject "Health science" taught only by  
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6 320 qualified teachers, in contrast to the other Nordic countries where sexuality education  
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8 321 can be integrated in any other school subject and has a less well-defined curriculum.  
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10 322 Subsidies of contraceptives have been suggested to lower pregnancy rates. However,  
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12 323 Denmark, without any subsidies at all has a higher contraceptive user rates and a lower  
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14 324 abortion rate than Sweden, which offers subsidies for young women. This is in keeping  
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16 325 with the findings from an English study where staying in school rather than the  
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18 326 promotion of LARC seemed to have a higher impact on the teenage pregnancy rate.[46]  
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20 327 On the other hand, in the CHOICE study where subsidies were combined with an  
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22 328 extensive promotion of LARC in the St Louis area of the USA, the teenage pregnancy rate  
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24 329 did decrease.[47] Also, a recent study from Finland where LARC was provided free-of-  
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26 330 charge in one large community, but not in another, reported an increased uptake of  
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28 331 LARC methods and a declining rate of abortions among all teenagers in the community  
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30 332 with free-of-charge LARC.[48] In Sweden there have been temporary and regional  
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32 333 declines in abortion rates when local subsidies have been launched together with  
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34 334 promotion campaigns for e.g. LARC, but the impact on the overall and long-term  
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36 335 abortion rate has been difficult to detect. In 2002 Norway introduced on a national level  
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38 336 its subsidy of COC to teenagers 16-19 years of age and in 2006 it was expanded to partly  
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40 337 fund all hormonal contraceptive methods for teenagers, except LNG-IUS. A strength of  
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42 338 the Norwegian subsidy system compared to the Swedish is probably that it is  
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44 339 nationwide.  
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46 340 In conclusion, we report steadily declining teenage birth and abortion rates, high user  
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48 341 rate of hormonal contraceptives and an increasing use of LARC. A number of factors that  
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50 342 could possibly influence contraceptive use and pregnancy rates have been discussed,  
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52 343 such as easy access to youth clinics, promotion of LARC and sexuality education  
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54 344 programmes. These factors would be of great interest to investigate further.  
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## 348 CONTRIBUTORSHIP

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HH, FES, OH, KGD, IM, OL and IL developed the study design. HH, IL, FES, OH and OL collected the data and HH, FES, OH, KGD, IM, OL and IL analysed the data. The first draft of the manuscript was prepared by HH and IL and FES, OH, KGD, IM, OL contributed in a critical discussion regarding the final manuscript. HH, FES, OH, KGD, IM, OL and IL had access to the data and approved of the final version of the manuscript submitted.

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**COMPETING INTERESTS**

All authors have completed the Unified Competing Interest form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf) (available on request from the corresponding author) and declare that IL has received compensation from Bayer AG, MSD and Actavis for lectures and participation in an Advisory Board during the previous three years; FES – has over the past three years nothing to disclose; KGD has served ad hoc on advisory boards or as invited speaker for Bayer AG, Merck/MSD, Actavis, HRA-Pharma, Exelgyn, Mithra, NaturalCycles and Gedeon Richter; OH has served ad hoc on advisory boards or as invited speaker for Bayer AG, MSD, Actavis, Exelgyn, Sandoz and Gedeon Richter; HH has had no relationships with any company in the previous three years; IM has served ad hoc on advisory boards or as invited speaker for Bayer AG, Gedeon Richter and Actavis during the previous three years; ØL has within the last three years received

379 honoraria for presentation/lectures in pharmacoepidemiologic issues. For all authors,  
380 their spouses, partners or children have no financial interests that may be relevant to  
381 the submitted work.

#### 382 **DATA SHARING**

383 Aggregated data from national registries used in the study are available at reasonable request  
384 from the corresponding author. Consent for data sharing was not obtained, but the presented  
385 data are anonymous and there is no risk for identification of individual patients.

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For peer review only



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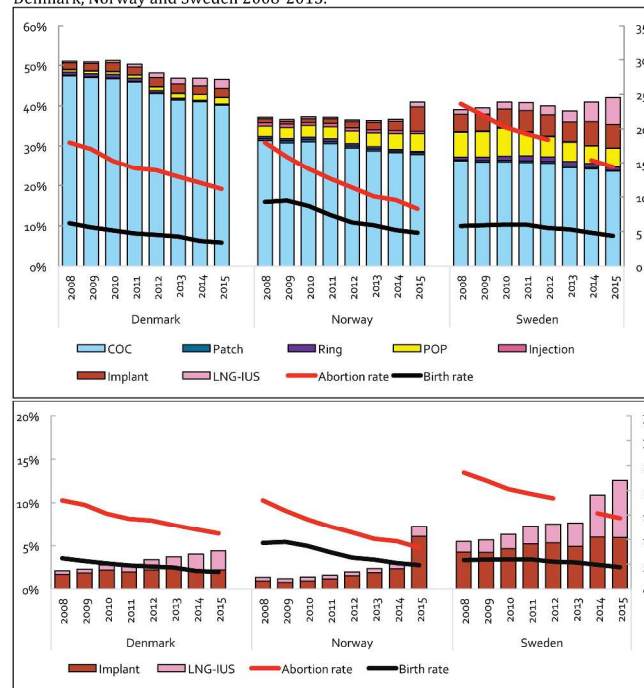
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549 **FIGURE LEGENDS**

550 **Figure 1 a)** Contraceptive use, birth and abortion rates among teenagers (15-19 years  
551 of age) in Denmark, Norway and Sweden 2008-2015.  
552 **1 b)** Use of LARC (long-acting reversible contraception including implants and  
553 levonorgestrel-releasing intrauterine systems), birth and abortion rates among  
554 teenagers in Denmark, Norway and Sweden 2008-2015.  
555 **Figure 2a-c.** Contraceptive use, birth and abortion rates among teenagers (13-19 years  
556 of age) in Denmark, Norway and Sweden 2008-2015 according to age groups. Please  
557 note the different scales.  
558 **Figure 3 a-c.** Use of LARC (long-acting reversible contraception including implants and  
559 levonorgestrel-releasing intrauterine systems), birth and abortion rates among  
560 teenagers (13-19 years of age) in Denmark, Norway and Sweden 2008-2015 according  
561 to age groups. Please note the different scales.  
562

**Figure 1 a)** Contraceptive use, birth and abortion rates among teenagers (15-19 years of age) in Denmark, Norway and Sweden 2008-2015.

**1 b)** Use of LARC (long-acting reversible contraception including implants and levonorgestrel intrauterine systems), birth and abortion rates among teenagers in Denmark, Norway and Sweden 2008-2015.



Y1 (left): Use of hormonal contraception (%). Y2 (right): Birth and abortion rates (number of women/1000 women and year).

Age-stratified abortion rates were not available for 2013 for Sweden.

CHC = combined hormonal contraception (subgroups oral, vaginal and transdermal);

POP = middle or low dose progestogen-only pill; Injection = depot medroxyprogesterone acetate (DMPA); LNG-IUS = levonorgestrel-releasing intrauterine system

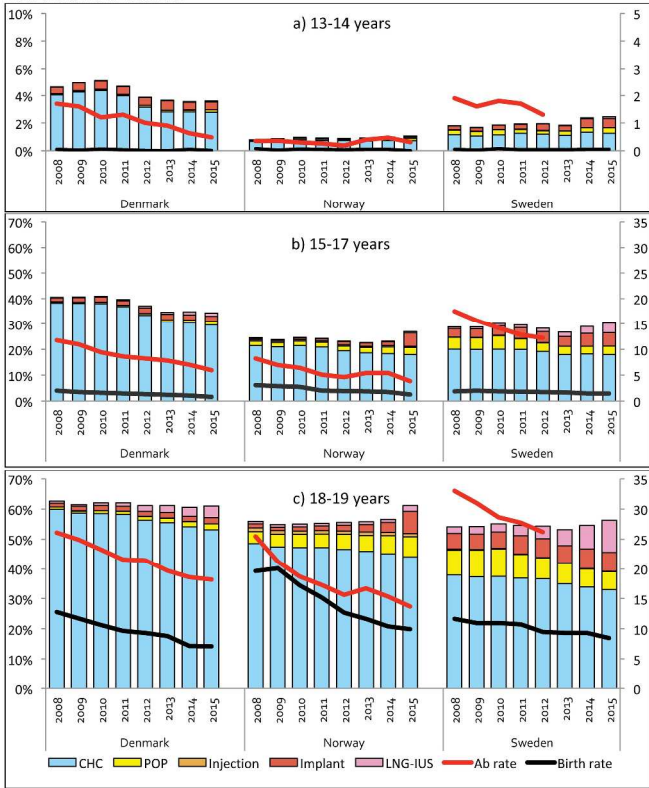
Figure 1 a) Contraceptive use, birth and abortion rates among teenagers (15-19 years of age) in Denmark, Norway and Sweden 2008-2015.

1 b) Use of LARC (long-acting reversible contraception including implants and levonorgestrel-releasing intrauterine systems), birth and abortion rates among teenagers in Denmark, Norway and Sweden 2008-2015.

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**Figure 2a-c.** Contraceptive use, birth and abortion rates among teenagers (13-19 years of age) in Denmark, Norway and Sweden 2008-2015 according to age groups. Please note the different scales.



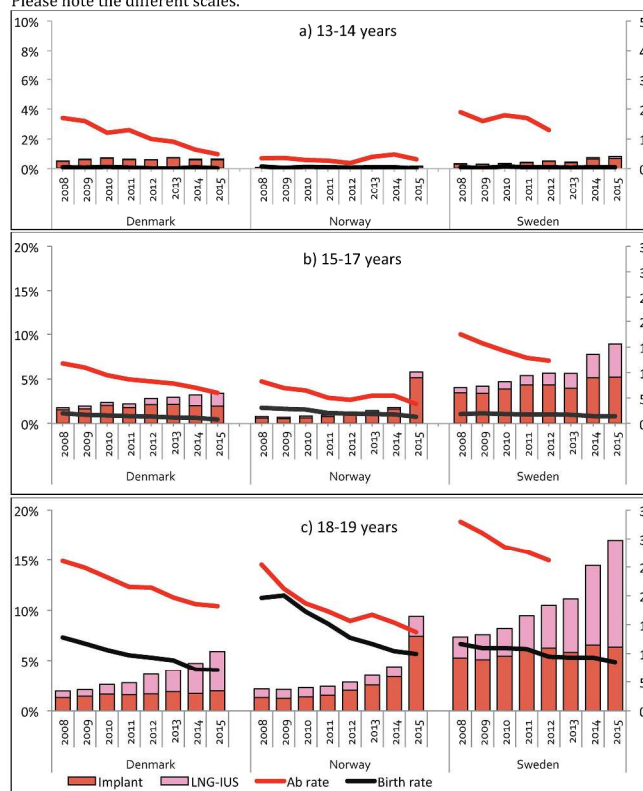
Y1 (left): Use of hormonal contraception (%). Y2 (right): Birth and abortion rates (number of abortion or births/1000 women). Please note the different scales. Age-stratified abortion rates were not available for 2013-15 for Sweden. CHC = combined hormonal contraception (subgroups oral, vaginal and transdermal); POP = middle or low dose progestogen-only pill; Injection = depot medroxyprogesterone acetate (DMPA); LNG-IUS = levonorgestrel-releasing intrauterine system, ab rate = abortion rate

Figure 2a-c. Contraceptive use, birth and abortion rates among teenagers (13-19 years of age) in Denmark, Norway and Sweden 2008-2015 according to age groups. Please note the different scales.

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**Figure 3 a-c.** Use of LARC (long-acting reversible contraception including implants and levonorgestrel intrauterine systems), birth and abortion rates among teenagers (13-19 years of age) in Denmark, Norway and Sweden 2008-2015 according to age groups. Please note the different scales.



Y1 (left): Use of LARC (%). Y2 (right): Birth and abortion rates (number of abortion or births/1000 women). Please note the different scales.  
Age-stratified abortion rates were not available for 2013-15 for Sweden.  
LNG-IUS = levonorgestrel-releasing intrauterine system, ab rate = abortion rate

Figure 3 a-c. Use of LARC (long-acting reversible contraception including implants and levonorgestrel-releasing intrauterine systems), birth and abortion rates among teenagers (13-19 years of age) in Denmark, Norway and Sweden 2008-2015 according to age groups. Please note the different scales.

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5,6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5,6
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5,6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	n.a.
		(c) Explain how missing data were addressed	n.a.
		(d) If applicable, describe analytical methods taking account of sampling strategy	n.a.
		(e) Describe any sensitivity analyses	n.a.
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	n.a.
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	n.a.
		(b) Indicate number of participants with missing data for each variable of interest	n.a.
Outcome data	15*	Report numbers of outcome events or summary measures	7-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n.a.
		(b) Report category boundaries when continuous variables were categorized	n.a.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n.a.
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## An ecological study on the use of hormonal contraception, abortions and births among teenagers in the Nordic countries

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<b>Primary Subject Heading</b>:	Obstetrics and gynaecology
Secondary Subject Heading:	Epidemiology
Keywords:	Teenagers, Hormonal contraception, Births, Abortions, Contraceptive use

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**An ecological study on the use of hormonal contraception, abortions and births among teenagers in the Nordic countries**

Running title: Hormonal contraception, abortions and births among teenagers in the Nordic countries

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## ABSTRACT

**Objectives:** Compare hormonal contraceptive use, birth and abortion rates among teenagers in the Nordic countries. A secondary aim was to explore plausible explanations for possible differences between countries.

**Design:** Ecological study utilising National registry data concerning births and abortions among all women aged 15-19 years resident in Denmark, Finland, Iceland, Norway and Sweden 2008-2015. Age specific data on prescriptions for hormonal contraceptives for the period 2008-2015 were obtained from national databases in Denmark, Norway, and Sweden.

**Setting:** Denmark, Finland, Iceland, Norway and Sweden.

**Participants:** Women 15-19 years old in all Nordic countries (749 709) and 13-19 years old in Denmark, Norway and Sweden (815 044).

**Results:** Both annual birth rates and abortion rates fell in all the Nordic countries during the study period. The highest user rate of hormonal contraceptives among 15-19 year olds was observed in Denmark (from 51 to 47%) followed by Sweden (from 39 to 42%) and Norway (from 37 to 41%). Combined oral contraceptives were the most commonly used methods in all countries. The use of long-acting reversible contraceptives (LARC), implants and the levonorgestrel-releasing intrauterine systems, were increasing, especially in Sweden and Norway. In the subgroup of 18-19 years old teenagers the user rates of hormonal contraceptives varied between 63 to 61% in Denmark, 56 to 61% in Norway and 54 to 56% in Sweden. In the same subgroup the steepest increase of LARC was seen, from 2 to 6% in Denmark, 2 to 9% in Norway and 7 to 17% in Sweden.

**Conclusions:** Birth and abortion rates continuously declined in the Nordic countries among teenagers. There was a high user rate of hormonal contraceptives, with an increase in the use of LARC especially among the oldest teenagers.

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**STRENGTHS AND LIMITATIONS OF THIS STUDY**

- The main strength of this study was the use of national register data, including all adolescents in the Nordic countries.
- In this study data on redeemed prescriptions has been used since it has been shown to be more reliable than self-reported use of contraceptives.
- Non-hormonal contraceptives are not registered in any of the national databases and hence were not included in this study.
- Since personal identification data is not recorded for contraceptive sales in Finland and Iceland, use of hormonal contraceptives were only available from Denmark, Norway and Sweden.

**TRIAL REGISTRATION NUMBER:** Not applicable

**KEY WORDS:** Teenagers; Contraceptive use; Abortion; Births; Hormonal contraception

**ABBREVIATIONS:**

COC –Combined oral contraception, CHC –Combined hormonal contraception, POP Progestogen only pill, LARC –Long-acting Reversible Contraception, LNG-IUS –Levonorgestrel-releasing intrauterine system



## 70 INTRODUCTION

71 Teenage pregnancy is regarded as a challenge both to society and the teenager.[1]  
72 Adolescent pregnancy and motherhood is associated with low socioeconomic status,  
73 early school leaving, and poor health of the mother during and after pregnancy.[2-6].  
74 Also the child of a teenage mother is at risk both during the perinatal period and in the  
75 long-term.[2] Socioeconomic deprivation is considered to be both an effect of and a risk  
76 factor for teenage births. Hence ill-health and low socioeconomic status are often  
77 disseminated across generations.[6 7] Women experiencing teenage motherhood or  
78 teenage abortion are also at risk of having another unplanned pregnancy. [8-10]  
79 In the United States and Europe the rates of teenage pregnancies are declining [11], but  
80 there is a large variation both between the United States and Europe, and within the  
81 European continent.[12] The outcome of pregnancies differs greatly, where in some  
82 regions most of the teenage pregnancies end with an induced abortion, while in others a  
83 pregnancy is usually continued to term. Although the United States has witnessed a  
84 steadily declining teenage pregnancy rate (57/1000 in 2011), it is still comparable to the  
85 highest rates seen in the east-European countries. For example, an incidence of 60/1000  
86 of adolescent pregnancy has recently been reported from Romania and Bulgaria.[12] In  
87 Northern Europe pregnancy rates vary between high levels of pregnancies and births in  
88 England and Wales (47/1000 in 2011) and much lower overall pregnancy rates in the  
89 Nordic countries and Ireland.[12-14]  
90 The declining rate of teenage pregnancy in the Nordic countries has been documented in  
91 several studies.[15-17] It has been suggested that an increasing availability of  
92 contraceptives is one of the reasons for the decline. Patterns of contraceptive use among  
93 teenagers have been described in individual Nordic countries [16 18 19] and as part of  
94 European surveys. [20 21] However, recent and comprehensive studies, including data  
95 on both pregnancies and contraceptive use among all Nordic teenagers, are lacking.  
96 The aim of this study was to compare hormonal contraceptive use, birth and abortion  
97 rates among teenagers in the Nordic countries. A secondary aim was to explore  
98 plausible explanations for possible differences between countries.

99 MATERIAL AND METHODS

100 National data on abortion and birth rates among teenagers were compiled from the five  
101 Nordic countries Denmark, Finland, Iceland, Norway and Sweden from 2000 to 2015.

102 Data regarding the use of hormonal contraceptives for the period 2008-2015 were only  
103 available from Denmark, Norway and, Sweden as personal identification data is not  
104 recorded for contraceptive sales in Finland and Iceland.

105 Information on birth and abortion rates were collected from the National Health  
106 Registries[22] and the Tigrab Database[23] in Denmark, The National Institute for  
107 Health and Welfare in Finland [24], the Directorate of Health in Iceland,[25] the  
108 Norwegian Institute of Public Health[26] and the National Board of Health and Welfare  
109 in Sweden.[27] Birth and abortion rates were expressed as the number of births or  
110 abortions/1000 women and year in a certain age group according to international  
111 practice. When displaying the overall teenage birth and abortion rates, all births or  
112 abortions during one year among women  $\leq 19$  years of age were included. Even though  
113 there is a small number of births and abortions among women younger than 15 years of  
114 age, the age group 15-19 was still used as a denominator in accordance with  
115 international practice.[28] Age was further categorised into three groups (13-14, 15-17  
116 and 18-19 years).

117 In Sweden the collection of abortion data was temporarily stopped in 2013. When  
118 collection started again in 2014, only data for 5-year-intervals of age were available,  
119 thus Sweden was not able to provide data for the sub-groups of 13-14, 15-17 and 18-19  
120 year-olds from 2013 and onwards.

121 National data on redeemed prescriptions of hormonal contraceptives in the Nordic  
122 countries were collected from the Danish National Registry of Medicinal Product  
123 Statistics, [29] the Norwegian Prescription Database[30] and the National Board of  
124 Health and Welfare in Sweden.[27] The collected data provides information on sold  
125 packages or items of different types of contraceptives expressed as defined daily doses  
126 (DDD). Use of combined oral contraceptives (COC), progestogen-only pills (POP), the  
127 contraceptive patch, the vaginal ring and the injection were expressed as DDD per 100  
128 women-years (%). To be able to compare the levonorgestrel-releasing intrauterine  
129 system (LNG-IUS) with the other contraceptive methods, the mean duration of use for  
130 the two LNG-IUSs available during the study period were set to four [31] and two years,

respectively.[32] Similarly, we calculated duration of use for the etonogestrel implant to be two years according to the average duration of use reported in previous studies. [31 33] All prescribed hormonal contraceptives to women  $\leq 19$  years of age were included when user rates among 15-19-year-olds were estimated, although a small number of prescriptions were for women below 15 years of age. As for abortion and birth rates, we also estimated hormonal contraceptive user rates for the age groups 13-14, 15-17 and 18-19 years.

Use of copper-IUD, condoms, diaphragms and fertility awareness methods were not estimated since these methods are not registered in any national data bases. Since personal identification data is not recorded for hormonal emergency contraceptives these methods are not included either.

Since all variables were collected on a group level from anonymised data including all teenagers, also teenagers who were infertile, not heterosexually active, pregnant or wished to get pregnant were part of the study population.

Demographic data for the Nordic countries were obtained from the database *Facts about the Nordic region*. [34]

### **Ethical considerations**

All data included in the study was either already in the public domain or anonymised on receipt.

The legal aspects of utilization of registry data for study purposes in Denmark and Norway were performed in accordance with national legislation. For Norway, the board of the Norwegian Prescription Database reviewed the protocol and gave permission for use of the data. Studies using anonymous data from nationwide registers are by Norwegian legislation exempted from the need of institutional regulatory board approvals and written informed consent from the patients. The specific permissions from the relevant body were in Denmark achieved from Datatilsynet (journal no [2010-41-4778](#)).

In Finland, Iceland and Sweden no permission was required as these data are publicly available from the national bodies of these countries. Since patients were not directly involved in the study and only anonymised data was used no ethical consent was needed.

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**Patient and public involvement**

There was no direct involvement in the study by patients, since only aggregated and anonymised data were used.

**Statistical methods**

In these purely descriptive analyses, no confidence intervals were calculated for the country specific rates. Since all female teenagers in each specific age group were included even small differences were highly significant.

**RESULTS**

**Population**

In 2015 the overall study population comprised 749 709 women 15-19 years old in the Nordic countries. When restricting the analysis to 13-19 years old women in Denmark, Norway and Sweden the study population comprised 815 044 teenagers (2015).

**Births, abortions and use of hormonal contraception among teenagers 15-19 years**

The birth rates fell from 8 to 3/1000 women 15-19 years in Denmark, 10 to 6 in Finland, 23 to 8 in Iceland, 12 to 5 in Norway and 7 to 4 in Sweden from 2000 through 2015 (Figure 1a).

The abortion rates fell from 14 to 11/1000 in women aged 15-19 years in Denmark, 15 to 8 in Finland, 25 to 13 in Iceland, 20 to 8 in Norway and 20 to 14 per 1000 teenagers in Sweden. (Figure 1b). Both birth and abortion rates decreased which resulted in an overall decline of teenage pregnancy rates in all countries.

The overall use of hormonal contraceptives varied between 51% to 47% in Denmark, 37% to 41% in Norway and 39% to 42% in Sweden from 2008 through 2015 (Figure 2a). COC was the most commonly used contraceptive method in all countries, but more frequently used among Danish teenagers, while POP were more common in Sweden (7 to 5%) and Norway (3 to 4%). The use of LARC, including implants and the LNG-IUS increased from 2 to 4% in Denmark, 1 to 7% in Norway and 5 to 12% in Sweden. In

Sweden and Denmark the increase of LARC consisted mainly of a higher use of LNG-IUS, In Norway there was no increase in the use of LNG-IUS, but the use of implants increased from 1 to 6% Figure 2b).

### **Age-stratified births, abortions and use of hormonal contraceptives in Denmark, Norway and Sweden, 2008-2015**

The birth and abortion rates over the years 2008 through 2015 were very low among 13-14 year-old teenagers in all three countries Births varied between 0 and 0.1 per 1000 teenagers a year in all three countries. Abortion rates varied between 1.7-0.5 in Denmark, 0.3-0.4 in Norway and 1.9 -1.3 per 1000 teenagers in Sweden (during 2008-2012 in Sweden, no data available 2013-2015) . The use of hormonal contraceptives was also very low in this age group (from 5 to 3% in Denmark, 1% in Norway and from 1 to 2% in Sweden). (Figure 3a and Figure 4a).

Birth rates varied around 2 per 1000 teenagers yearly in all three countries among 15-17-year-olds. The abortion rates in the same age group declined from 12 to 6 in Denmark, 8 to 4 in Norway and 17 to 12 per 1000 teenagers in Sweden (during 2008-2012 in Sweden, no data available 2013-2015). Denmark had a markedly higher use of hormonal contraceptives (from 40 to 34%) than Norway (from 25 to 27%) and Sweden (from 29 to 30%) among 15-17-year-olds. Combined hormonal contraception (CHC) were the most commonly used method in all countries. Use of LARC, including implants and LNG-IUS, increased from 2 to 3% in Denmark, 1 to 6% in Norway and 4 to 9% in Sweden. (Figure 3b and Figure 4b)

A more marked decrease of the birth rate was seen among 18-19-year-olds in Norway (from 20 to 10 per 1000 teenagers) compared to the other two countries (from 13 to 7 in Denmark and from 12 to 9 in Sweden), where Norway started off on a higher level in 2008. The abortion rates in the same age group declined from 26 to 18 per 1000 in Denmark, from 25-14 in Norway and 33 to 26 per 1000 teenagers in Sweden (during 2008-2012 in Sweden, no data available 2013-2015). The overall user rates of hormonal contraceptives among teenagers 18-19 years of age varied between 63 to 61% in Denmark, 56 to 61% in Norway and 54 to 56% in Sweden. CHC were the most commonly used method in all countries. Use of LARC, including implants and LNG-IUS, increased from 2 to 6% in Denmark, 2 to 9% in Norway and 7 to 17% in Sweden. (Figure 3c and Figure 4c).

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226 **DISCUSSION**

227 Birth and abortion rates among teenagers in all the Nordic countries have declined

228 between 2008 and 2015. During the same time period more than half of the 18-19-year

229 old women were using hormonal contraception. The use of long-acting reversible

230 contraception (LARC) increased, especially among 18-19 year olds, while there was a

231 small reduction in the use of CHC and POP. Birth and abortion rates were low in the

232 Nordic countries compared to overall worldwide rates among teenagers.[12] Moreover,

233 the decreasing rate of teenage births has not been offset by an increasing abortion rate.

234 The strength of this study was the use of national register data, which included all

235 adolescents in the Nordic countries. All the registries are considered reliable. However

236 redeemed prescriptions do not necessarily mean that the contraceptives actually have

237 been used. Nevertheless, when assessing contraceptive use, pharmacy claims have been

238 shown to be more reliable than self-reported use, as women tend to overestimate their

239 contraceptive use.[35] Online purchases of pharmaceutical drugs without a registered

240 prescription are not included in the study. Since prescribed hormonal contraceptives are

241 available and affordable to most adolescents in the Nordic countries, the proportion of

242 online purchases without a prescription is not considered to be significant. A limitation

243 in this study was the lack of age specific data on contraceptive use from Finland and

244 Iceland.

245 Although declining, Sweden had the highest teenage abortion rate and the reasons for

246 that are not obvious. The observed differences in overall user rates of hormonal

247 contraceptives could not explain the differences in abortion rates since e.g. Norway had

248 a lower user rate than Sweden, but still had lower abortion rates.

249 The risk of unplanned pregnancies is determined by three main factors; the proportion

250 of sexually active women in the studied age group, the proportion of women using any

251 contraceptive method and the efficacy of the contraceptive used.

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253 Concerning sexual activity a study including 65 000 women in Denmark, Iceland,

254 Norway and Sweden reported that the number of sexual partners and median age for

255 first intercourse (16 years) was the same in all countries.[36] However the study only



covers the years 2004-2005. The declining pregnancy rate seen in all the Nordic countries during the study period could be due to postponed time of first intercourse and/or declining sexual activity among teenagers, but there is no recent studies to support or reject this statement.

Regarding the second identified factor, proportion of contraceptive users, there were only small differences between the three Nordic countries studied and the proportion did not increase more in countries with the steepest decrease in births and abortion rates. The timing of initiation of contraceptive use might play a role though since it has been shown that initiation before or at first intercourse is associated with lower future abortion rates compared to initiation after the first intercourse.[37] We were not able to estimate the proportion of women using other methods such as copper-IUDs, condoms, fertility awareness methods and emergency contraceptives. According to national[16 18 38] and European studies[20 39], condoms are a frequently used contraceptive method among teenagers with pronounced user dependent efficacy. There might be differences in condom use between the Nordic countries that can influence the pregnancy rates.

The third important factor is the quality of the contraceptive use. There is robust scientific evidence of the high efficacy of LARC methods [40 41]. During the last 10-15 years the promotion of LARC as the most effective form of contraception has increased and it has been reflected in e.g. national guidelines on contraception. This recommendation also applies to teenagers. Both Norwegian, Swedish, and to a lesser extent, Danish teenagers have increased their use of LARC (including LNG-IUS and implants) at the expense of CHC and POP during the most recent years. There was a shift towards recommending LARC already in the guidelines for contraception in 2005 in Sweden but in the updated guidelines from 2014 LARC was strongly recommended as a first option also for teenagers. Norway has made similar recent updates for recommendations of LARC. In 2014 also a smaller LNG-IUS (Jaydess®) was introduced on the market as an IUS especially well suited for young women. It is likely that these actions are at least some of the reasons for the increasing use of LARC seen in this study, especially among 18-19 year-old women. During the same period of time abortion rates in all the countries included in this study have reached their all-time-low mark.



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289 Sexual activity, contraceptive user rate and the quality of the contraceptive use can be

290 influenced by a number of factors. Simultaneously with the liberalisation of the abortion

291 laws in the 1970's the Nordic countries also focused on easy access to contraceptives,

292 establishment of family planning services, youth clinics and sexuality education

293 programmes. The implementation of these routines differed to some extent between

294 countries. To ensure easy access to contraceptives GPs in Denmark and Norway were

295 given the main responsibility for prescribing contraceptives, although since 2006 public

296 health nurses and midwives has also been granted authorisation to prescribe hormonal

297 contraceptives. In Sweden midwives have been the main prescriber since the 70s.

298 Unfortunately they have to a great extent been left without medical advisors, which

299 might influence their recommendations of contraceptives. For instance, the relatively

300 high use of POP shown in this study in Sweden might be due to the fact that there are

301 fewer contraindications for POP than CHC and without the necessary medical support it

302 is safer to prescribe POP than CHC although POP has a lower continuation rate. [42]

303 It has been suggested that sexuality education programmes may lower teenage

304 pregnancy rates by postponing the first sexual intercourse and by increasing both

305 contraceptive user rates and quality of use. There is however a wide variety of

306 programmes and from the studies it is difficult to draw conclusions about the extent to

307 which programmes actually affect teenage pregnancy rates in practice.[43] A Cochrane

308 review of school-based sexuality education programmes found no evidence of an impact

309 on pregnancy rates. There was however a low grade of evidence for an impact of

310 incentives to stay in school on lower pregnancy rates. It should be noted that the

311 majority of the studies included in the review were from low to middle-income

312 countries.[44] All the Nordic countries have compulsory sexuality education in schools

313 but Finland has the most extensive programme of all the countries. Finland, with the

314 current lowest abortion rate among the Nordic countries, witnessed an increase in the

315 abortion rate in the mid-1990's just after the programme were no longer considered

316 mandatory. After reinstituting a comprehensive compulsory sexuality education

317 programme again in all Finnish schools in the early 2000's, the abortion rate dropped

318 again. [45] In Finland the programme is part of the specific school subject "Health

319 science" taught only by qualified teachers, in contrast to the other Nordic countries

where sexuality education can be integrated in any other school subject and has a less well-defined curriculum.

It has also been suggested that subsidies of contraceptives can lower pregnancy rates. However Denmark, without any subsidies at all has a higher contraceptive user rates and a lower abortion rate than Sweden, which offers subsidies for young women. This is in keeping with the findings from an English study where staying in school rather than the promotion of LARC seemed to have a higher impact on the teenage pregnancy rate.[46] On the other hand, in the CHOICE study where subsidies were combined with an extensive promotion of LARC in the St Louis area of the USA, the teenage pregnancy rate did decrease.[47] Also, a recent study from Finland where LARC was provided free-of-charge in one large community, but not in another, reported an increased uptake of LARC methods and a declining rate of abortions among all teenagers in the community with free-of-charge LARC.[48] In Sweden there have been temporary and regional declines in abortion rates when local subsidies have been launched together with promotion campaigns for e.g. LARC, but the impact on the overall and long-term abortion rate has been difficult to detect.

In conclusion, we report steadily declining teenage birth and abortion rates, high user rate of hormonal contraceptives and an increasing use of LARC. A number of factors that could possibly influence contraceptive use and pregnancy rates have been discussed, such as easy access to youth clinics, promotion of LARC and sexuality education programmes. These factors would be of great interest to investigate further.

#### CONTRIBUTORSHIP

HH, FES, OH, KGD, IM, OL and IL developed the study design. HH, IL, FES, OH and OL collected the data and HH, FES, OH, KGD, IM, OL and IL analysed the data. The first draft of the manuscript was prepared by HH and IL and FES, OH, KGD, IM, OL contributed in a critical discussion regarding the final manuscript. HH, FES, OH, KGD, IM, OL and IL had access to the data and approved of the final version of the manuscript submitted.

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**COMPETING INTERESTS**

All authors have completed the Unified Competing Interest form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf) (available on request from the corresponding author) and declare that IL has received compensation from Bayer AG, MSD and Actavis for lectures and participation in an Advisory Board during the previous three years; FES – has over the past three years nothing to disclose; KGD has served ad hoc on advisory boards or as invited speaker for Bayer AG, Merck/MSD, Actavis, HRA-Pharma, Exelgyn, Mithra, NaturalCycles and Gedeon Richter; OH has served ad hoc on advisory boards or as invited speaker for Bayer AG, MSD, Actavis, Exelgyn, Sandoz and Gedeon Richter; HH has had no relationships with any company in the previous three years; IM has served ad hoc on advisory boards or as invited speaker for Bayer AG, Gedeon Richter and Actavis during the previous three years; ØL has within the last three years received honoraria for presentation/lectures in pharmacoepidemiologic issues. For all authors, their spouses, partners or children have no financial interests that may be relevant to the submitted work.

**DATA SHARING**

379 Aggregated data from national registries used in the study are available at reasonable request  
380 from the corresponding author. Consent for data sharing was not obtained, but the presented  
381 data are anonymous and there is no risk for identification of individual patients.

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**FIGURE LEGENDS**

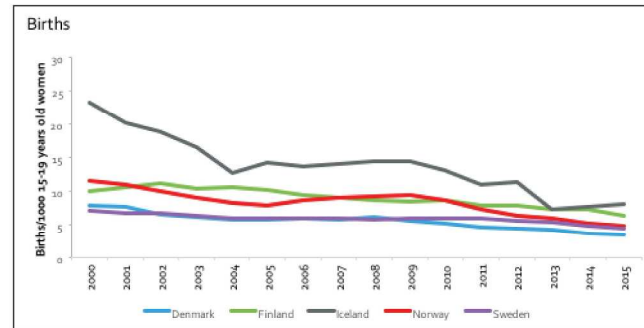
**Figure 1 a)** Births/1000 women aged 15-19 during 2000-2015 in the Nordic countries  
**Figure 1 b)** Abortions/1000 women aged 15-19 during 2000-2015 in the Nordic countries

**Figure 2 a)** Contraceptive use, birth and abortion rates among women aged 15-19 in Denmark, Norway and Sweden 2008-2015.  
**Figure 2 b)** Use of LARC (long-acting reversible contraception including implants and levonorgestrel-releasing intrauterine systems), birth and abortion rates among women aged 15-19 in Denmark, Norway and Sweden 2008-2015.  
Y1 (left): Use of hormonal contraception (%). Y2 (right): Birth and abortion rates (number of women/1000 women and year).  
Age-stratified abortion rates were not available for 2013 for Sweden.  
COC = combined oral contraception; POP = middle or low dose progestogen-only pill; Injection = depot medroxyprogesterone acetate (DMPA); LNG-IUS = levonorgestrel-releasing intrauterine system

**Figure 3 a-c.** Contraceptive use, birth and abortion rates among women aged 13-19 in Denmark, Norway and Sweden 2008-2015 according to age groups. Please note the different scales.  
Y1 (left): Use of hormonal contraception (%). Y2 (right): Birth and abortion rates (number of abortion or births/1000 women). Please note the different scales.  
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**Figure 4 a-c.** Use of LARC (long-acting reversible contraception including implants and levonorgestrel-releasing intrauterine systems), birth and abortion rates among women aged 13-19 in Denmark, Norway and Sweden 2008-2015 according to age groups. Please note the different scales.  
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**Figure 1 a)** Births/1000 women aged 15-19 during 2000-2015 in the Nordic countries



**Figure 1 b)** Abortions/1000 women aged 15-19 during 2000-2015 in the Nordic countries

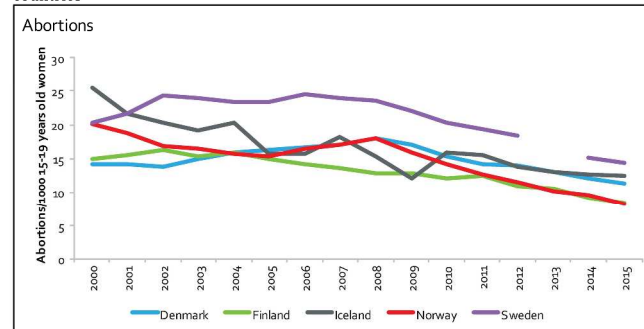
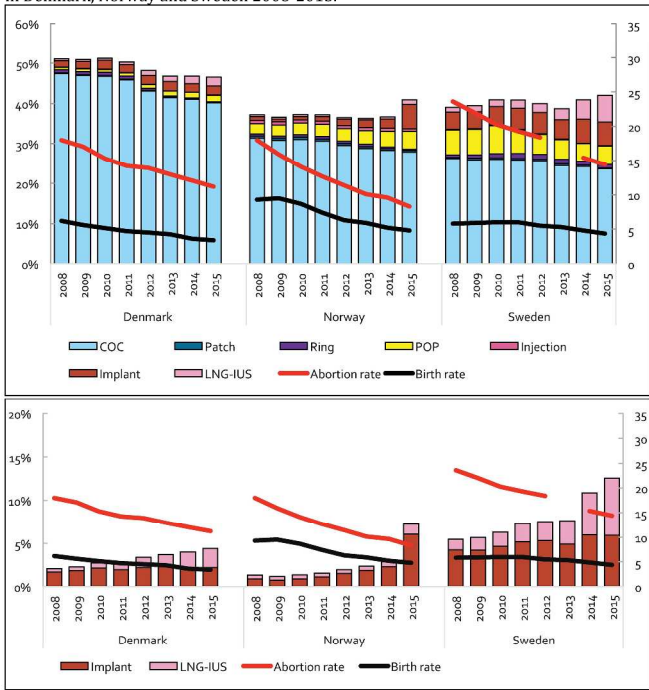


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Figure 1 b) Abortions/1000 women aged 15-19 during 2000-2015 in the Nordic countries

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**Figure 2 b)** Use of LARC (long-acting reversible contraception including implants and levonorgestrel intrauterine systems), birth and abortion rates among women aged 15-19 in Denmark, Norway and Sweden 2008-2015.



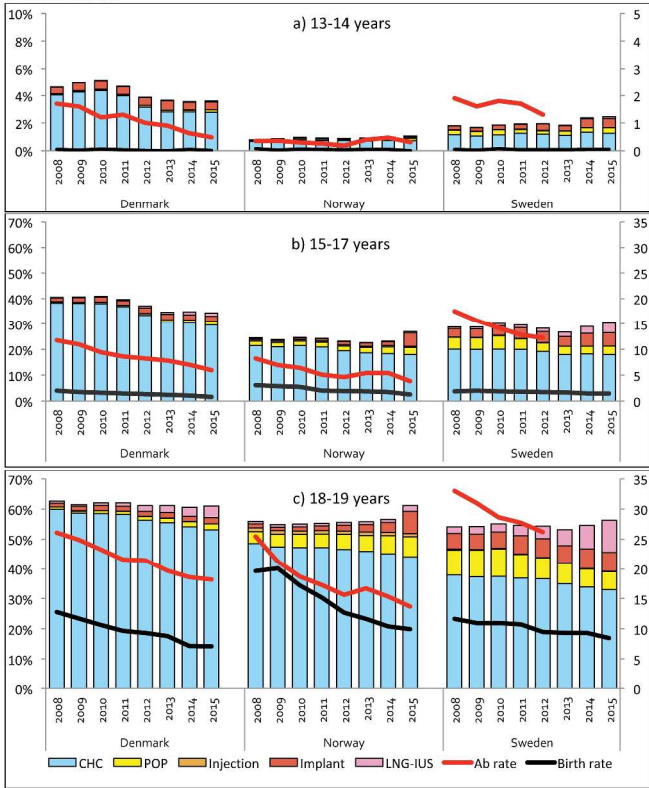
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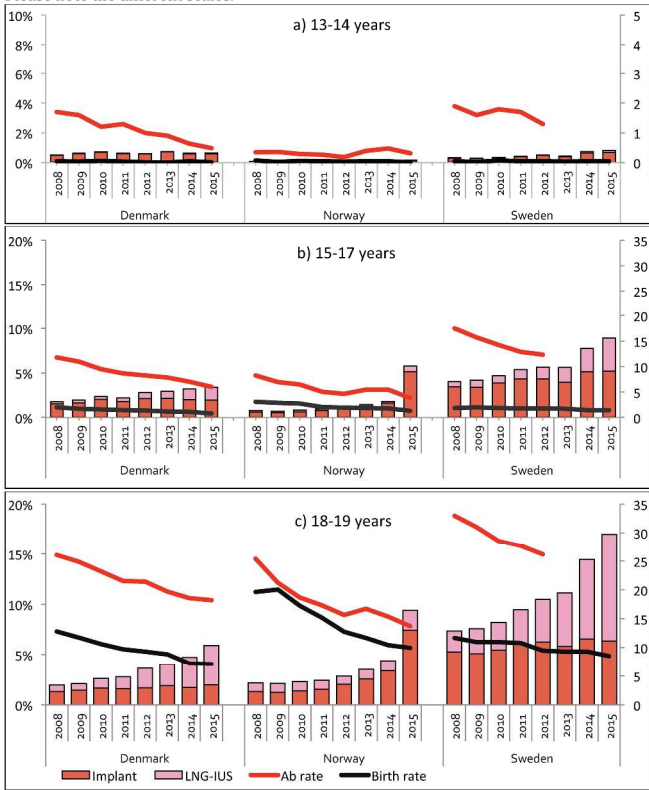
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**STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies***

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5,6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5,6
Bias	9	Describe any efforts to address potential sources of bias	
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5,6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	n.a.
		(c) Explain how missing data were addressed	n.a.
		(d) If applicable, describe analytical methods taking account of sampling strategy	n.a.
		(e) Describe any sensitivity analyses	n.a.
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	n.a.
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	n.a.
		(b) Indicate number of participants with missing data for each variable of interest	n.a.
Outcome data	15*	Report numbers of outcome events or summary measures	7-9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n.a.
		(b) Report category boundaries when continuous variables were categorized	n.a.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	n.a.
Discussion			
Key results	18	Summarise key results with reference to study objectives	9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9-12
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).